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BUREAU OF PLANT INDUSTRY

OFFICE OF COTTON, TRUCK, AND FORAGE CROP DISEASE INVESTIGATIONS

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WART OF POTATOES: A DISEASE NEW TO THE UNITED STATES



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DISCOVERY OF POTATO WART IN THE UNITED STATES.

THE DREADED WART DISEASE of the Irish potato has been discovered in the United States. A letter accompanied by specimens of the disease was sent from Highland, Pa., to Prof. J. G. Sanders, of the Pennsylvania Department of Agriculture at Harrisburg, about the middle of last September. Highland is a small village located near Freeland, in Luzerne County, in the anthracite coal-mining region of Pennsylvania. A hasty survey of this region has shown the presence of the disease in 27 cities and villages in Luzerne, Schuylkill, and Carbon Counties. All except three of these points of infection lie within a rather small area, about 18 miles in length and 12 miles in breadth. The three points outside of this area are not very distant from each other or from the region of general infection.

In some villages the disease was found in only a few gardens, while in others 50 or more gardens showed its presence. Its severity varied greatly in different places. In a few gardens the infection was so severe as practically to destroy the crop, and it was learned that in most of these places the wart had been present for at least four years.

WHERE THE WART DISEASE CAME FROM.

The wart is believed to have come into the United States on potatoes imported from European countries. This disease has been gradually spreading over Europe, and in recent years has done considerable damage, especially in England and Ireland. The United States Department of Agriculture gave warning of the danger of importing this wart in Circular No. 52, issued in 1910 (15),* and in Farmers' Bulletin 489 (23). In the hope of keeping it out of America, the Federal Horticultural Board in 1912 placed an embargo on potatoes coming from countries where the disease was known to exist. This embargo became effective on September 20, 1912. Before it took effect, however, several million bushels of the crop of 1911 had been shipped into this country from Europe. Twelve carloads of these potatoes are known to have been distributed in the district where the disease now occurs. Whether or not the wart has established itself in other parts of the country where European potatoes were

*The serial numbers in parentheses refer to "Literature cited," pp. 13-14.

shipped is not at present known. It will not be surprising, however, if other points of infection are found, and *potato growers, potato buyers, market inspectors, and especially county agents, should be on the lookout for it in all parts of the country.* Like many other diseases, the wart is easier to prevent than to control. It is highly important that all localities where it occurs be discovered as soon as possible, in order that proper measures may be taken to prevent its further spread.

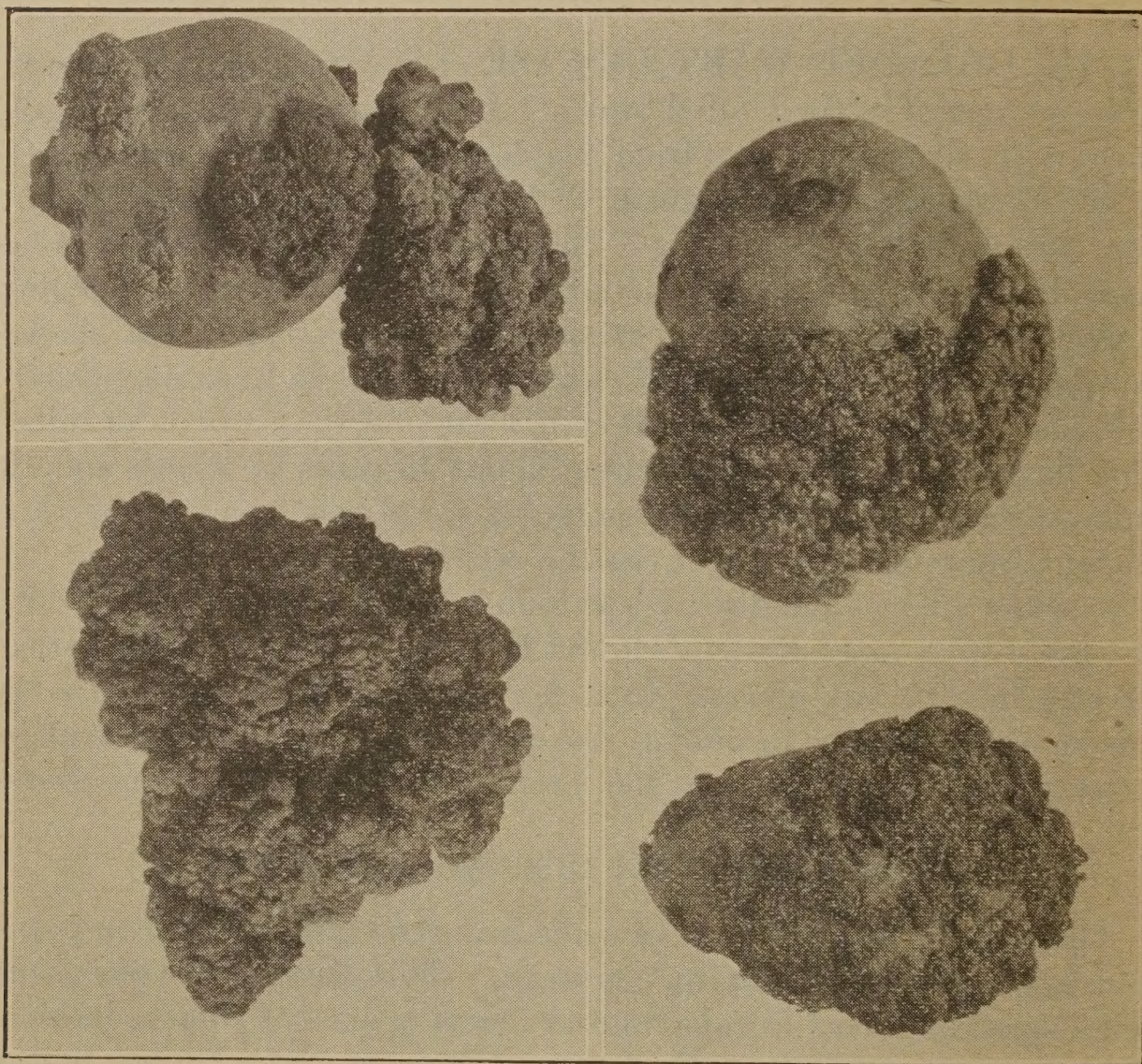


FIG. 1.—Some potato tubers showing different stages of the wart disease.

EFFECT OF THE DISEASE ON THE POTATO PLANT.

As the name indicates, the disease is characterized by warty outgrowths on the underground portions of the plant. The warts vary greatly in size, but are frequently as large as a walnut. Some warted tubers are shown in figure 1. Infections usually start at the eyes, but may take place at other points on the surface of the tuber. Sometimes entire tubers are converted into a spongy, warty mass, as shown in figure 2. Badly warted tubers are unsalable and for the most part unfit for food. The oversucculent tissues of the warts are highly susceptible to attack by parasitic fungi and bacteria. Many of the warts rot in the ground before the crop is harvested,

while others rot soon after the potatoes are put into storage. Frequently, however, especially in the case of small warts, the tissues dry down before being attacked by secondary rot-producing organisms.



FIG. 2.—A potato stalk, showing warts taking the place of potato tubers.

In such cases the diseased tubers keep through the winter. Young warts are usually light brown in color. After decay begins they turn black, and this has led English authors to refer to the disease as “black scab” or “black wart.” Some of the warts left on the field at digging time may remain alive under suitable conditions for months. Young warts when exposed to light become green. Sound warts frequently send up sprouts, such as are shown in figure 3. New warts may arise from the tender portions of such young sprouts. In this way the disease may continue to vegetate long after the potato crop has been harvested.

The warts occur abundantly on the tubers, stolons, and underground portions of the main stem. They occur sparingly on the roots and have been reported on potato leaves that came in contact with infested soil (3). So far as known, the disease never seriously affects the growth of the potato vines. It does not kill the host plant.

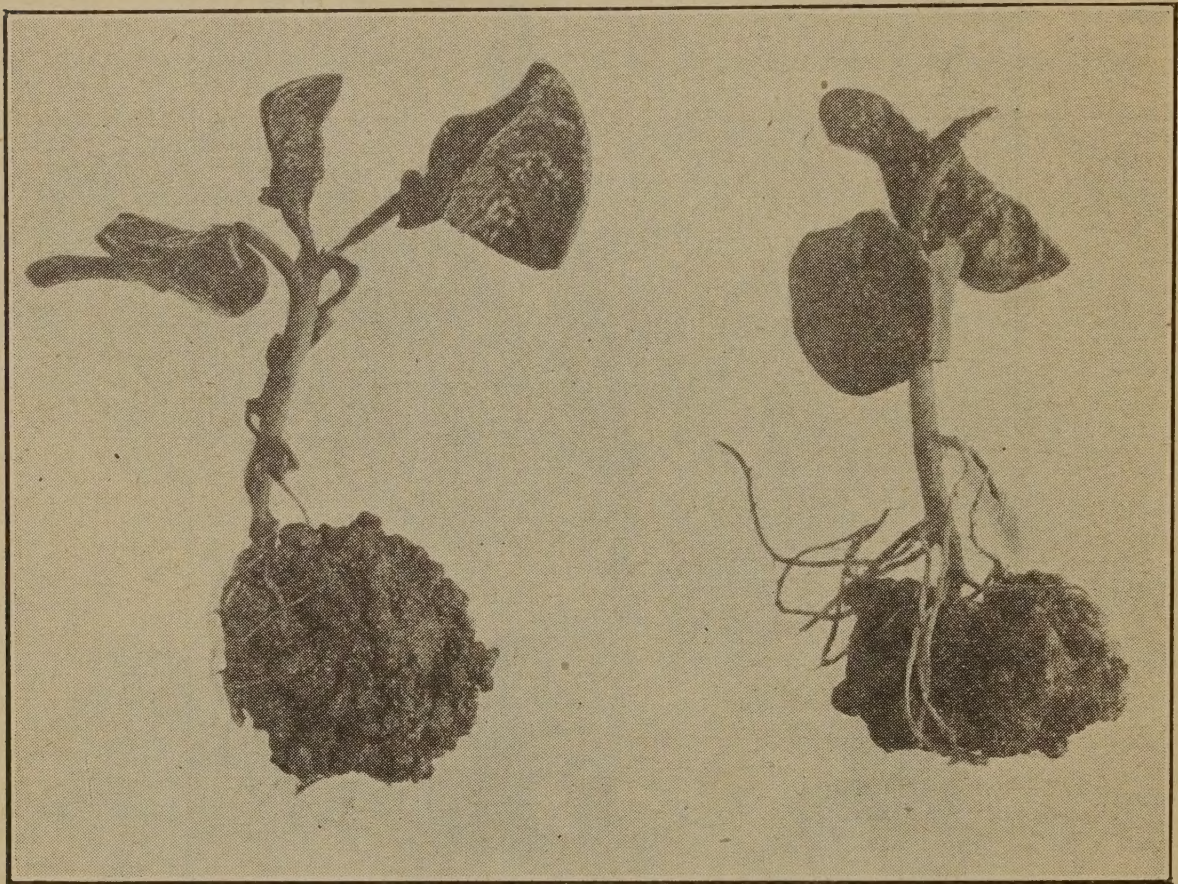


FIG. 3.—Two warts that were left in the soil at digging time; the sprouts furnish material for the continued vegetation of the disease.

With the exception of the nightshade (*Solanum nigrum* L.) and the bittersweet (*S. dulcamara* L.), two closely related solanaceous plants, the potato is the only plant known to be attacked by the wart disease (4).

NATURE OF THE DISEASE.

The wart is caused by a parasitic fungus (*Chrysophlyctis endobiotica* Schilb.), which was named and described by Schilberszky, a Hungarian scientist, in 1896 (20). It is one of the lowest members of the Chytridiaceæ, a group of parasites that attack the stems, leaves, and especially the roots of many wild and cultivated plants. Although it belongs in the same great group of fungi as the common bread mold, it produces no mold growth and is so small that it can hardly be seen with the naked eye. Percival (16), who studied the disease, thought the causal fungus should be placed in the genus *Synchytrium*, but more recent work by Bally (2) indicates that it should continue to bear the name Schilberszky originally gave it.

The parasite propagates itself by means of minute yellow-colored globular bodies called sporangia. The sporangia are produced in great numbers just beneath the surface of the wart. Though the parasite does not go very far into the potato, it nevertheless exerts a powerful stimulating influence on the potato tissue. This stimulation causes the potato cells to undergo rapid growth and division and leads to the formation of the large warts. When the outer tissues of the warts rot, the sporangia are set free in great numbers. They are of two kinds, summer sporangia and resting sporangia. The summer sporangium is surrounded by a thin wall or shell, while the shell of the resting sporangium is quite thick. The summer sporangium germinates as soon as mature. The spores produced may infect other parts of the same plant and lead to the production of new warts. The resting sporangia, on the other hand, may remain dormant for long periods of time (19). In fact, there seems to be good evidence that, buried in the soil, they may, like the seeds of certain higher plants, lie inactive for years. Finally, when by cultivation or other means they are brought under suitable conditions, germination takes place. On germinating, each sporangium sets free not one but a whole litter of spores. The spores are tiny oval-shaped free-swimming bodies which move about in the soil water. If no potato plants are growing in the soil they soon die for lack of food, but if potato plants are at hand they settle down around the eyes of the tuber or on the other tender portions of the plant. Here they bore into the surface layers of tissue and feed on the substance of the living potato cells. This stimulates the plant to such an extent that it produces the large warts which are so characteristic of the disease.

SERIOUSNESS OF THE DISEASE.

Wart is usually considered to be one of the most serious of potato diseases. It has done considerable damage in certain districts of England and in Ireland. Most English authorities (4) hold that it is a very serious disease. Appel (1), Remy (17), and Spieckermann (24), on the other hand, seem to consider it of little economic importance.

The disease has frequently been very severe in small gardens where potatoes are grown year after year on the same plats. It has not been so severe in fields where crop rotation is practiced. One writer (6) says: "The disease has caused most damage in gardens or allotments where potatoes are grown every year, but in a few cases there has also been serious loss in potatoes grown in a 4-year rotation." The writer observed the disease in gardens in Pennsylvania during the past autumn. In some gardens the infection was so severe that the crop was practically a total loss. Three short rows taken at random

in one badly infested garden were dug at harvest time. These rows gave approximately 150 hills, but not a single sound potato was obtained. All of the tubers were more or less warted, and many of them were entirely converted into warty overgrowths. Apparently the severity of the disease depends on the degree of infestation of the soil. This, in turn, depends on the number of diseased potato plants that have been grown per unit of area in previous years and on the thoroughness with which the spores have been distributed throughout the soil. Each infected crop, by liberating millions of spores, adds momentum to the disease. If potatoes are grown year after year on the same field, a point is finally reached where the soil is so filled with viable resting sporangia that not a single plant or even a single tuber can escape infection. In such a soil it is no longer possible to grow sound tubers, and under such conditions the disease is one of the most destructive of all those that attack the potato. On the other hand, it may prove that where a proper rotation of crops is maintained there is little to fear from the wart disease.

HOW THE DISEASE MAY BE SPREAD.

The wart, like many other soil diseases, is not seriously or widely distributed by the wind. Under ordinary conditions it spreads slowly. The sporangia in the soil or on tubers must be carried to other soils before new infections can be started. The sporangia may be carried into clean soil by drainage from infested soil, by farm implements used to cultivate infested soil, on the feet of men or animals, by planting diseased tubers or tubers that have been in contact with diseased tubers, or by planting sound tubers that have been grown on infested soil, by the use of manure from animals to which diseased tubers have been fed, and by garbage into which warts or peelings from diseased tubers have been thrown. There are, of course, many other ways by which the disease may be spread. Any agency that distributes infested soil or infected tubers is sure to spread the disease.

Every precaution should be taken to prevent the spread of the sporangia. The warts should be collected and destroyed by burning. Diseased tubers should not be fed to stock without first being boiled. Soil known to be infested should be planted to other crops. Potatoes should not be planted again during a period of at least eight years. Attempts to control the disease by treating infected soil with chemicals (9, 4), such as sulphur, lime, and formaldehyde, have not been successful.

RESISTANT VARIETIES.

It has been found in European countries that certain potato varieties resist this disease. Some sorts are even said to be immune. In Scotland the Golden Wonder and Peacemaker varieties have been found to be very resistant (22). The Langworthy, Conquest, Abundance, Croften, and Twentieth Century are examples of resistant English varieties (8). Some resistant German varieties are Paulsen's Juli, Goldperle, Professor Maerker, Topaz, and Lech (25). Certain of the English varieties, as, for example, Great Scott, are claimed to be immune to the disease (7). From the experience of European workers it would seem that the finding of resistant or immune varieties offers the best method for controlling the disease. American varieties of potatoes have not yet been tested for resistance to wart.

IS THE AMERICAN POTATO INDUSTRY SERIOUSLY THREATENED BY THIS NEW DISEASE?

Unless the disease has already established itself outside the district now known to be infested, there seems to be no great danger of its spreading to our commercial potato-growing regions. It is fortunate that the infested area in Pennsylvania does not lie in an agricultural section of the State. The gardens in which the disease occurs are usually small, and the country surrounding them is overgrown with brush and small timber. No potatoes or other vegetables are grown except for home or local use. The entire region is so isolated that the danger of the disease spreading would seem to be at a minimum. With proper restrictions and quarantine measures, such as the Pennsylvania State Department of Agriculture proposes to take, there seems to be no immediate danger of the wart getting into our commercial potato-growing districts.

MEASURES TAKEN BY GREAT BRITAIN FOR THE CONTROL OF WART.

Some valuable suggestions may be obtained from a study of the measures taken in Great Britain for the control of potato wart. It was made a notifiable disease under the "Destructive Insects and Pests Act." Three orders have been issued by the Department of Agriculture and Technical Instruction for Ireland. They were issued in 1908, 1913, and 1918, respectively, and show to a certain extent the development of control measures.

The order of 1908 provided (a) that all persons must notify the department in case they find warty potatoes or potatoes suspected of having wart; (b) that a determination be made of infested areas; (c) that notice be sent to owners of infested areas that (1) all potatoes, potato haulms, and packages used for storing or transporting diseased

potatoes be immediately destroyed by burning or other suitable means; (2) no potatoes, potato haulms, etc., be removed from infested districts without a license; (3) potatoes be not again planted on infested soil without the sanction of the Department of Agriculture; (4) no soil from infested areas be removed or taken to any other locality; and (d) that it be unlawful to import warty potatoes into Ireland.

The order of 1913 provided (a) that movement of potatoes out of certain scheduled districts be under license; (b) that no potatoes be planted, dug, or removed within certain prohibited areas except under license; (c) that no potatoes grown within prohibited areas be used for seed purposes; (d) that no potato stalks or other parts of the plant grown in prohibited areas be moved; and (e) that in prohibited areas no uncooked potatoes, either alone or mixed with other materials, be fed to live stock or poultry or be spread on land or manure heaps.

The order of 1918 makes it illegal to plant any but approved immune varieties in an infested area. The sale of seed of immune varieties is placed under license.

MEASURES PROPOSED FOR FIGHTING THE WART IN PENNSYLVANIA.

(1) *Quarantine and restrictive measures.*—The infested area in Pennsylvania is soon to be placed under quarantine. The growing of potatoes on infested soil will be prohibited for a number of years. Every precaution will be taken to prevent the disease from spreading.

(2) *Eradication work.*—On account of the small size of most of the gardens in which the disease occurs in Pennsylvania, it has been suggested that some kind of soil sterilization might be practicable, especially in cases where only two or three gardens in a village show infestation. If after a careful survey the disease should not be found in any other section of the United States, it would be very desirable if some means could be found to stamp it out in Pennsylvania. With these considerations in mind, the United States Department of Agriculture proposes to undertake in a preliminary way during the year 1919 the sterilization of infested soil by the steam-pan method. The sterilization will be carried out on some of the more outlying infestations, and an effort will be made to determine what temperatures are effective in killing the sporangia in the soil. The time required for effective work will also be determined. Should the steam-pan method prove effective and practicable as a means of exterminating the disease in the soil, it might be used over a larger area in future years; in fact, the known areas of infestation are so small that it would not be an impossible task to sterilize all of them by this method. Although

sterilization may not furnish a means of entirely eradicating the disease, it will probably prove of considerable value in holding it in check.

(3) *Investigations on wart.*—The United States Department of Agriculture, in cooperation with the Pennsylvania Agricultural Experiment Station, proposes to undertake an investigation of the disease as it occurs in this country. As an aid to these investigations, a field laboratory will be established near Freeland, Pa.

All of our more important commercial potato varieties will be grown in infested soil, and their resistance to the disease will be determined. A number of promising seedlings developed by the Bureau of Plant Industry will also be subjected to this test. It is hoped that among this large number of varieties a few will be found that are highly resistant or even immune.

Most of the resistant English and Scotch varieties will also be grown in Pennsylvania, in order to test their resistance in this country. If none of our own varieties prove resistant, it is hoped that some of the foreign ones will adapt themselves to our conditions to such an extent as to be suitable for planting on infested lands.

HISTORY OF THE DISEASE.

Our earliest description of the wart disease of potatoes was written by Schilberszky in 1896 (20). The specimens on which this description was based came from upper Hungary, but no mention is made of the prevalence or severity of the disease at that time. Since it may have been present in the fields several years before specimens reached Schilberszky, there is no way of determining just when the trouble first made its appearance in Hungary.

The wart disease was prevalent in the Liverpool district of England as early as 1893 (18), and some reports indicate that it may have been there at a much earlier date (12, 6). It was known among English potato growers more than 35 years ago and long before it was described by Schilberszky (9). Its presence was not reported, however, until 1902.

Although it is not possible to say where the disease originated, we know that it was not widely distributed in Europe at the time it was first observed in England. Since that time it seems to have spread rather widely. It is now seriously present and doing great damage in many counties of England (4). It reached Ireland about 1908 and has recently been doing considerable damage there (13). It has also spread to Scotland and Wales.

The wart disease was first reported from Germany in 1908, but is known to have been present there at least three years earlier (14).

It first appeared at Berghausen in the Rhine Province. It was found near Düsseldorf and at Vohwinkel, near Elberfeld, in 1908 (5). It has also been found near Hamburg, and was reported from Silesia in 1909 (10).

The wart was discovered in Newfoundland in 1909 (11). This was its first appearance in America. It was found in two localities near Christiansand, Norway, in 1914 (21). In spite of precautions which were taken by the Norwegian Government to hold it in check, it appeared in 27 new localities in 1915. According to Güssow, the wart has been recorded in both France and Italy (11).

The disease was first found in the United States about the middle of September, 1918. It is known to have been present in gardens at Upper Lehigh, Pa., however, as early as the summer of 1914. At that time it was noticed in some gardens by the miners. That it may have been present for several years before being observed seems probable.

L. O. KUNKEL.

Approved:

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Chief of Bureau.

FEBRUARY 1, 1919.

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